

Examiner Interview before any further actions on the merits.

The applicant will now address each of the issues raised in the outstanding Office Action.

Objections

The drawings were objected to under 37 C.F.R. § 1.83(a), for failing to show every feature of the invention specified in the claims. More specifically, the Examiner asks to see windings being independently connected with the H-bridge circuits of a power switching stage without inter-connections, the rotor having empty spaces between each magnet in the rotor, the photo-sensors positioned operatively with the commutation encoder and the rotor laminations. (See Paper No. 5, page 2.) The applicant refers the Examiner to Figs. 1, 3B, 4A, 4B, 5A and 5B of the application as an exemplary embodiment including all the specified elements.

Windings independently connected with the H-bridge circuits of a power switching stage without inter-connections are shown in Figs. 3B and 5A. Fig. 3B illustrates the stator winding of a 5 phase 6-polarity motor implemented in accordance with the invention. It can be seen from Fig. 3B that the windings per phase are independent of each other. Referring to Fig. 5A, the windings coupled to the H-bridges represent the windings for each phase illustrated in Fig. 3B. The H-bridges of Fig. 5A share the same power source, but the windings that

are coupled to the H-bridges do not share any interconnections.

An example of a rotor having empty spaces between its magnets and rotor laminations is shown in Figs. 4A and 4B. In Figs. 4A and 4B, the black strips, which are labeled as permanent magnets, extend radially from the shaft of the rotor. The rotor laminations are labeled as silicon steel, and have either a "N" or a "S" printed on them. Empty spaces between the magnets are also labeled as the triangle shapes between the laminations.

An exemplary photo-sensor positioned operatively with the commutation encoder is shown in Fig. 1. The commutation encoder is labeled in the upper right hand corner, and the small rectangle located close to the encoder is a photo sensor. Another example is shown in Fig. 5B. The photo-sensors are labeled PA1-PE1, PA2-PE2, and they are positioned operatively with the commutation encoder, which is the circular plate with sensing and non-sensing regions.

In view of the foregoing remarks, the applicant respectfully submits that the claimed features are shown by the drawings. Accordingly, the applicant respectfully requests that the Examiner reconsider and withdraw this objection.

Rejections under 35 U.S.C. § 112

Claims 5 and 6 stand rejected as being unpatentable under 35 U.S.C. § 112, ¶ 1 as containing

subject matter that was not described in the specification in such a way as to reasonably convey to one skilled in the art that the inventor, at the time the application was filed, had possession of the claimed invention. The applicant respectfully requests that the Examiner reconsider and withdraw this ground of rejection in view of the following.

The Examiner posits that a new formula for sensing regions is recited in claim 6. The applicant refers the Examiner to the formula disclosed in the specification on page 8, lines 2-4, as describing the formula in claim 6. The equation in the specification is as follows:

The width of the sensing region

$$= \{2\pi / (\text{number of polarities} \times \text{number of phases})\} \times$$

 number of phases to be excited^(°)

The equation in claim 6 is as follows:

$$\frac{2\pi}{\text{the number of poles in the rotor}} \times \frac{(n-b)\text{phases}}{\text{the number of phases}} (\text{degrees})$$

Although the two equations are arranged in a different way, they are mathematically equivalent. For example the equation in the specification may be rearranged, without changing the equation mathematically, as:

$$\frac{2\pi}{\text{number of polarities}} \times \frac{\text{number of phases to be excited}}{\text{number of phases}} (\text{°})$$

The variable "n" represents the total number of phases, and the variable "b" represents the number of inexcited phases. Therefore, n-d represents the number of excited phases. In view of this explanation and reference to the specification, the applicant respectfully asks that the Examiner reconsider and withdraw the rejection under 35 U.S.C. § 112, ¶ 1.

The Examiner also posits that power transistors and photo transistors are not supported by the specification. The applicant has amended claim 5 to use the terms "H-bridge" and "photo-sensors" instead, which conform with that used in the specification (See, e.g., page 5 line 33 to page 6 line 15.). In view of this explanation, the applicant respectfully asks that the Examiner reconsider and withdraw the rejection under 35 U.S.C. § 112, ¶ 1.

Claims 1-6 stand rejected as being unpatentable under 35 U.S.C. § 112, ¶ 2 as failing to particularly point out and distinctly claim the invention. The applicant respectfully requests that the Examiner reconsider and withdraw this ground of rejection in view of the following.

The Examiner asks about the winding configuration of the present invention. The applicant will explain the winding connections with reference to Fig 3B. Fig. 3B illustrates the windings of each phase being independent from the windings of any other phase. Therefore the windings are independently connected. The windings for each phase are coupled, in parallel pairs, to their own H-bridge. Each H-bridge shares the same power source, but

the windings of each phase coupled to the H-bridge have no interconnections.

The windings of Fig. 1 illustrates one pair of windings per phase. There are 5 phases. Therefore Fig. 1 shows 10 windings. Each winding is located 180 degrees from its pair, and the windings per phase are lying on top of each other, but there is no interconnection between the windings of each phase. In light of this explanation and reference to the specification, the applicant respectfully asks that the Examiner reconsider and withdraw the rejection under 35 U.S.C. § 112, ¶ 2.

Claim 5 has been amended to define the variable (n-b). Therefore, the applicant respectfully asks that the Examiner reconsider and withdraw the rejection under 35 U.S.C. § 112, ¶ 2.

Rejections under 35 U.S.C. § 103

Claims 1 and 2 stand rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 4,882,524 (hereafter referred to as "the Lee patent"), in view of U.S. Patent No. 2,903,610 (hereafter referred to as "the Bessiere patent"), and in view of U.S. Patent No. 5,982,067 (hereafter referred to as "the Sebastian patent"). Claims 3 and 4 stand rejected under 35 U.S.C. § 103 as being unpatentable over the Lee patent, in view of the Bessiere patent, in view of the Sebastian patent and in view of ordinary skill in the art. Claim 5 is rejected under 35 U.S.C. § 103 as being unpatentable over the Lee patent, in view of the Bessiere patent, in view of the Sebastian

patent, in view of U.S. Patent No. 4,638,224 (hereafter referred to as "the Gritter patent") and in view of ordinary skill in the art. Claim 5 is rejected under 35 U.S.C. § 103 as being unpatentable over the Lee patent, in view of the Bessiere patent, in view of the Sebastian patent, in view of the Gritter patent, in view of U.S. Patent No. 5,866,959 (hereafter referred to as "the Le Flem patent") and in view of ordinary skill in the art. The applicant respectfully requests that the Examiner reconsider and withdraw this ground of rejection in view of the following.

Dependent claim 6 is not rendered obvious by the Lee, Bessiere, Sebastian, Gritter and Le Flem patents because these patents, either taken alone or in combination, fail to teach or suggest narrow slots adapted to eliminate flux cancel phenomenon between every winding slot. Claim 6, is reprinted below with the above identified distinguishing features depicted in bold typeface:

6. The motor according to claim 5
wherein
 **said stator has narrow
 slots adapted to eliminate flux
 cancel phenomenon between every
 winding slot** and to remove peak
current between said excited phase
and said inexcited phase.
[Emphasis added.]

As mentioned in the previous amendment, the present invention claims narrow slots for the elimination of the flux cancel phenomenon. The narrow slots of the Bessiere patent eliminate armature reaction. Cancel phenomenon is

the colliding of flux traveling in opposite directions through the stator, while armature reaction is the interference caused between the magnetic field of the permanent magnets of a stator and the magnetic field of the coils.

The Examiner references column 4, lines 3-8 of the Le Flem patent as disclosing the narrow slots between the winding slots, but the Le Flem patent teaches making the winding slots narrower. Making the winding slots narrower is not the same as having a narrow slot between every winding slot, e.g., in the teeth of the stator. The stator teeth of the Le Flem patent have holes in them (See Fig. 7.), but holes are not slots, and the stator teeth of the Le Flem patent may not eliminate flux cancel phenomenon because flux may flow through the bridge (reference number 116) of the stator tooth. The Examiner does not rely on the Lee, Sebastian and Gritter patents for this teaching. Accordingly, claim 6 is not rendered obvious by the Lee, Bessiere, Sebastian, Gritter and Le Flem patents for at least this reason.

The Examiner posits the cancel phenomenon is not well defined in the specification or in the claims, and cites two other definitions of cancel phenomenon (See paper No. 5, page 13.). A first definition is cited in U.S. Patent No. 5,856,995 (hereafter referred to as "the Morris patent"), and a second definition in U.S. Patent No. 5,669,063 (hereafter referred to as "the Brockel patent"). The cancel phenomenon is described in the specification on page 10, lines 32-34 and page 11, line 1 which states, that narrow slots in the stator remove collision of magnetic flux which is generated when the coil of each phase is

electrified. One skilled in the art would recognize the description as flux cancel phenomenon.

Flux cancel phenomenon is also recited in the claims. Claim 6 recites the elimination of flux cancel phenomenon. One skilled in the art would not confuse the colliding of flux traveling in opposite directions through a stator with the cancel phenomena of the cited patents. The cancel phenomenon of the Morris patent involves the cancellation of electric fields in the vicinity of an auxiliary electrode used to prevent degradation in cathode seals (See Column 2, lines 33-41 and lines 50-60.) The cancel phenomenon of the Brockel patent involves the fading of radio wave paths due to air masses of different temperatures and humidities that are overlying with each other and not mixing. (See column 3 line 66 to column 4 line 3.) These definitions of cancel phenomenon do not involve magnetic flux in a stator. Therefore one skilled in the art would recognize that flux cancel phenomenon is the colliding of flux traveling in opposite directions through a stator. Accordingly, the flux cancel phenomenon is recited in the specification and in claim 6.

Dependant claim 2 is amended to conform with recitations in dependant claim 6. Therefore one skilled in the art would also not be confused by other definitions of cancel phenomenon when reading claim 2. Accordingly, claim 2 is not rendered obvious by the Lee, Bessiere and Sebastian patents for at least this reason, and the flux cancel phenomenon is recited in claim 2.

New dependant claims 7 (and 9) further distinguishes the present invention from the Lee, Bessiere,

Sebastian, and Gritter patents because these patents, either taken alone or in combination, fail to teach or suggest two or more inexcited phases. Claim 7 is reprinted below with the above-identified distinguishing features depicted in bold typeface:

7. (NEW) The motor according to claim 3 wherein
 $n > b > 1$, **n corresponding to the number of phases, b corresponding to the number of inexcited phases.**
[Emphasis added.]

Claim 9 is the same except that it depends from claim 5.

The applicant agrees with the Examiner that each phase can be excited or inexcited (See paper 5, pages 12 and 13.), but the Lee patent only teaches having one phase inexcited at any given time in the operation of the motor. Claim 7 recites allowing b inexcited phases at any given time, b being a number greater than one. If a motor was constructed using the equations of the Lee patent, that motor would always have only one inexcited phase. This fact is illustrated in Figures 4A, 4B and 6 of the Lee Patent. The equations of the present invention can be used to manufacture motors with multiple inexcited phases. Accordingly, claim 7 further distinguishes the present invention from the cited patents.

New dependent claims 8 (and 10) further distinguishes the present invention from the Lee, Bessiere and Sebastian patents because these patents, either taken alone or in combination, fail to teach or suggest a constant-power brushless DC motor. Claim 8 is reprinted

below with the above-identified distinguishing features depicted in bold typeface:

8. (NEW) The motor according to
claim 1 wherein
constant power is delivered
by the motor. [Emphasis added.]

Claim 10 is the same except that it depends from claim 5.

Fig. 6 of the Lee patent shows the combination of the torque from the three phases outputs a rippled torque. This is reiterated in the description of the figures. (See column 2, lines 53-54.) The specification also explains that the torque of conventional motors is a sinusoidal or trapezoidal torque scheme, causing torque ripple. (See page 12, line 12-13.) The output torque of the present invention, on the other hand, is flat. More specifically, the motor of the present invention applies a partial square wave to the winding coil of each phase, allowing each phase to realize rectangular torque scheme. (See page 12, lines 14-17.) When rectangular torque schemes are added together they result in a flat output torque. This can be seen in Fig. 6 of the present application. The sum of the torque from phases A, B, C, D, and E is a constant torque. As is known in the art, torque is rotational force, therefore constant torque yields constant power. Accordingly, claim 8 further distinguishes the present invention from the cited patents.

The Examiner posits that the Lee patent discloses a brushless DC motor with a constant excitation winding phase which could lead to constant output power (See paper No. 5, page 12.). However, the Lee patent states, "the

motor is constituted so that the **exciting condition** of the winding coil of each phase **is always constant**" (column 3, lines 34-37). Therefore, the condition that excites the windings of a phase is constant (See Fig. 6), but the torque produced is sinusoidal. Therefore the brushless DC motor of the Lee patent does not lead to constant output power.

Entry of Amendments

Since the claim amendments merely explicitly recite an inherent characteristics of the claimed device, give the claim preamble weight, address issues previously raised, or address 112 concerns, they raise no new issues, place the application into condition for allowance, and should be entered.


Conclusion

In view of the foregoing amendments and remarks, the applicant respectfully submits that the pending claims

are in condition for allowance. Accordingly, the applicant requests that the Examiner pass this application to issue.

Respectfully submitted,

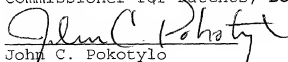
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CERTIFICATE OF MAILING under 37 C.F.R. 1.8(a)

I hereby certify that this correspondence is being deposited on **March 1, 2002** with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to the Assistant Commissioner for Patents, **BOX AF**, Washington, D.C. 20231.


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SEPARATE SHEET WITH MARKED-UP VERSION OF CLAIMS PER 37

C.F.R § 1.121(c) (1) (ii)

1 2. (AMENDED) The motor as claimed in claim 1, wherein the
2 stator has narrow slots to remove flux cancel phenomenon
3 between every winding slot and to remove peak current
4 between said excited phase and said inexcited phase.

1 5. (AMENDED) A constant-power brushless DC motor
2 comprising:
3 a stator constituted by at least two phases, each of
4 the phases having plurality of windings wound in a
5 distributed, parallel, winding and being independently
6 connected with the each H-bridge circuit of a power
7 switching stage without inter-connection;
8 a rotor rotatably coupled to said stator and having an
9 even plurality of permanent magnet poles, the motor having
10 said permanent magnet rotor in which the magnetic
11 arrangement is radial to the shaft and integral to said
12 rotor laminations, said rotor laminations having empty
13 spaces between every each magnet in said rotor; and
14 a commutation encoder externally set to one side of
15 the shaft of said rotor and having sensing regions and
16 nonsensing regions, wherein the number of phases among the
17 at least two phases, which will be excited, is determined
18 by the distance of each sensing region, wherein the
19 distance of said sensing regions being determined by the
20 following formula:

21
22
$$\frac{n}{a} = \frac{\text{total phases}}{\text{excited phases,}}$$

23 1, 2, 3, ...
24 1, 2, 3, ...
$$\frac{n}{b} = \frac{\text{total phases}}{\text{inexcited phases}}$$

25

26

$$\frac{2\pi}{\text{the number of poles in the rotor}} \times \frac{(n-b)\text{phases}}{\text{the number of phases}} (\text{degrees})$$

27

28 the number of said sensing regions is determined by the
29 following formula:

30

31

$$\frac{\text{number of poles}}{2} ;$$

32

33 [a] photo sensors [coupled] positioned operatively with
34 said commutation encoder and constituted so that two
35 [photo-transistors] photo-sensors are provided with respect
36 to each phase, each of said [photo-transistors] photo-
37 sensors in the at least two phases being arranged, in turn,
38 one by one at intervals of predetermined shaft angle so as
39 to produce a positive pulse when registered with said
40 sensing of said commutation encoder, and said interval in
41 determined by the following formula:

42

43

$$\frac{2\pi}{\text{the number of poles in the rotor}} \times \frac{1}{\text{the number of phases}} (\text{degrees}) ;$$

44

45 [a] an electronic commutator constituted such that
46 [four power transistors are] an H-bridge is connected across
47 the windings of each phase of said stator, [two of the four
48 power transistors] a half H-bridge of each phase being
49 connected to one [photo-transistor of said] photo-sensor so
50 that each phase is provided with two [photo-transistors]
51 photo-sensors so as to determine the current direction
52 according to the positive pulse of the [photo-transistors]
53 photo-sensors, thereby flowing the alternating current of
54 part-square wave through the windings to drive the motor,

55 and an electric power source connected in parallel to each
56 phase of said electronic commutator.

1 7. (NEW) The motor according to claim 3 wherein
2 $n > b > 1$, n corresponding to the number of phases, b
3 corresponding to the number of inexcited phases.

1 8. (NEW) The motor according to claim 1 wherein
2 constant power is delivered by the motor.

1 9. (NEW) The motor according to claim 5 wherein
2 $n > b > 1$, n corresponding to the number of phases, b
3 corresponding to the number of inexcited phases.

1 10. (NEW) The motor according to claim 5 wherein
2 constant power is delivered by the motor.